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T A B L E S
FOR
QUALITATIVE
CHEMICAL ANALYSIS.

WITH AN
INTRODUCTORY CHAPTER
ON THE
COURSE OF ANALYSIS.

BY
PROFESSOR HEINRICH WILL,
OF GIESSEN, GERMANY.
SECOND AMERICAN, FROM THE NINTH GERMAN EDITION.

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EDITOR'S PREFACE.

THE growing opinion in favor of increased attention to the study of Natural Science, as a branch of liberal education, on account of its *disciplinary* value, as well as the practical character of the knowledge acquired, led to a modification of the curriculum of study required for the degree of Bachelor of Arts in this institution, in so far as to allow of the election of more extensive and practical study of Natural Science in lieu of the Latin and Greek of the Junior and Senior years. The expectation is *not* in this way to turn out Bachelors of Arts as chemists, etc., but simply to make this branch of a liberal education as thorough as the times seem to demand, and to afford a foundation, if desired, for subsequent scientific pursuits.

In adapting a course of chemical analysis to this purpose the accompanying tables seemed peculiarly suited. Whilst compact, they are sufficiently explicit, and the summary view of the general course of qualitative analysis, and of the classification of compounds according to the properties relied upon for their detection, affords a thread, as it were, around which chemical facts may crystallize as they accumulate.

For details of properties, etc., in addition to instruction in the laboratory, the student is constantly referred to some one of the manuals of analytical chemistry placed in the laboratory for this purpose.

Whilst these tables seem thus well adapted to a course of college studies, their general popularity, as well as scientific character, is indicated by their extensive adoption in the German universities, and their indorsement by many of the most eminent chemists in this country, and their introduction, in part at least, into many laboratory handbooks.

This second American edition, prepared from the ninth German edition, contains, besides the marks of careful revision, two new tables by the author embodying Bunsen's valuable flame reactions,

and whilst nothing in the original has been omitted or changed, new matter has been freely added by the editor, generally placed in []. Thus other methods for the separation of the alkaline earths are given, and an additional table (XIV), which may replace parts of Tables VI and VIII with the advantage of greater simplicity and directness. The note in regard to the detection of titanio acid is inserted on account of its frequent occurrence in iron ores. The chapter on the "Course of Analysis," from the original, is added with the hope that it may relieve any inconvenience in directing the use of the tables.

In adopting a new nomenclature for a book of this character, compactness, completeness, and general intelligibility have been mainly considered.

Acknowledgment is made to many practical instructors for suggestions, especially to Professor F. A. GENTH, of the University of Pennsylvania.

CHARLES F. HIMES.

DICKINSON COLLEGE, Carlisle, Pa., 1874.

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BUNSEN'S FLAME REACTIONS, A METHOD OF ANALYSIS
IN WHICH THE GAS-LAMP IS SUBSTITUTED FOR THE BLOWPIPE,
WITH A FULL LIST OF SPECIAL REACTIONS. Translated by
Prof. C. F. HIMES, PH.D. 75 cts.

COURSE OF QUALITATIVE CHEMICAL ANALYSIS.

I. *Preliminary Examination and Solution of Solids.**—In the qualitative examination of a solid, its general nature must first of all be ascertained. This is accomplished by *an examination in the dry way*, which always necessarily precedes the qualitative analysis proper, in the wet way, and which includes with the careful observation of its physical characteristics (form, color, lustre, hardness, specific gravity, etc.) that of *its deportment at high temperatures*, either alone, with access of air, in the flame, or in the presence of other compounds, which may effect its decomposition or solution. The preliminary examination is conducted according to Tables I to IV, and serves not only to determine the general chemical nature of the body, and the quality of the metals and metallic oxides, but may also indicate the quality of some metalloids. Table XI serves exclusively for the *preliminary examination for acids*, and especially for *volatile acids*, or such as afford *volatile products of decomposition* with concentrated sulphuric acid.

No elucidation of these tabular statements is necessary for their application, as they explain themselves, and continued practical employment of them will impart the necessary degree of certainty to conclusions obtained by them. After the determination of the class of compounds, to which the substance under examination belongs, by the preliminary examination in the dry way, the conversion of it into the liquid form, alone suitable for analysis in the humid way, must be considered. In many cases this operation must be preceded by the preparation of the substance, by giving it the form best adapted to solution. If its nature permits, it must be *finely pulverized*, and sometimes also *elutriated*. This is especially indispensable with minerals, especially with silicates, as well as with all other compounds that are difficultly soluble, insoluble, or decomposable with difficulty.

* Substances placed in [] in the tables are of rare occurrence.

It must then first be ascertained whether the substance is *wholly* or *partially soluble*, or *totally insoluble* in water. If partially soluble the filtrate from the undissolved portion will leave a clearly perceptible residue, when evaporated on clean platinum foil or in a capsule, whilst if totally insoluble no such residue will be left. The reaction of the aqueous solution, whether it be *neutral*, *acid*, or *alkaline*, must also be determined by test-paper. If the substance dissolves only partially in water, the constituents of the dissolved and undissolved portions must be ascertained separately. If it is insoluble in water the effect of *dilute* and *concentrated chlorhydric acid* must be tried whilst note is taken of any evolution of gas in the operation; *carbonates* develop CO_2 with effervescence; superoxides or *chromates*, chlorine gas; *cyanides*, prussic acid; many *sulphides* H_2S ; *sulphites* and hypsulphites SO_2 , the latter with the separation of sulphur; some *reguline metals* (Zn, Fe, Sn, etc.) develop hydrogen gas with HCl, or in presence of arsenic, arsenetted hydrogen; in presence of antimony, antimonetted hydrogen. If solution in HCl is only partial, as a rule a separation of one or more constituents is effected by it, and the insoluble residue must be separated from the liquid, and dissolved by further treatment (Table V). A substance (or the residue) insoluble in HCl, must be treated with nitric acid or aqua regia. Many sulphides, with nitric acid, yield *sulphur*, which by sufficiently prolonged action collects as yellow globules, or disappears entirely, when newly formed sulphuric acid is always detected, unless the metallic oxide produced forms a compound with it insoluble in the acid. Thus *plumbic sulphide* (galena) affords plumbic sulphate with nitric acid; *sulphides of tin and antimony* are converted into *white oxides*; whilst mercuric sulphide is entirely unaffected by nitric acid, but dissolves very readily in aqua regia.

The reguline metals are almost all soluble in nitric acid, and such a metal unaffected by HNO_3 must contain Au, Pt, Ir, or the rarer metals in platinum ores. *Gold* and *platinum* are soluble in aqua regia; *palladium* also in HNO_3 ; *tin* and *antimony* are converted by HNO_3 into white oxides (insoluble in excess of the acid), and are readily dissolved in aqua regia, (or in HCl with KClO_3), if excess of HNO_3 is avoided.

A substance insoluble in and undecomposable by any of the acids mentioned, even by prolonged digestion at a moderate temperature, will be found in Table V, and must be rendered soluble (by fluxing), according to that table, after its general chemical

nature has been ascertained by a preliminary examination in the dry way (according to Tables I to IV).

II. *Qualitative Examination of the Substances in Solution.*— In a qualitative examination of a *liquid* (not a solution prepared by the investigator), it is necessary first to ascertain—

1. Whether *volatile* or *non-volatile* ingredients are present, by evaporating *a portion* of the liquid on platinum foil, or in a capsule. If a fixed residuum remain it must be subjected to the processes for the preliminary examination of solids, except of course such as relate only to solution.

2. Whether its reaction with test-paper is *neutral*, *acid*, or *alkaline*.

These tests should never be omitted, since, with care, the presence or absence of whole groups of substances can be inferred from the results. Thus it is plain that no fixed substance need be sought for in a solution which leaves no residuum upon *careful* evaporation, (that is, not produced by violent ebullition). A neutral liquid as a rule can only contain salts of the alkalis or alkaline earths, since the salts of nearly all other metallic oxides have an *acid* reaction. The presence of free alkali, (especially in the absence of non-volatile organic compounds), excludes all oxides insoluble in alkaline liquids, and if the alkaline reaction is due to an alkaline carbonate no alkaline earth can be present. (Among the exceptions to this rule are Fe_2O_3 , CuO , etc., in presence of non-volatile organic matter, as well as oxides, cyanides, sulphides, etc., soluble in potassic cyanide and alkaline sulphides.) The presence of certain metals also indicates the absence of certain acids, and *vice versa*; thus Ag need not be sought for in a reguline metal completely soluble in HCl , nor Au, Sn, or Sb, etc., in one soluble in HNO_3 .

A portion of the solution of a solid, produced in any way, is employed for the detection of the *metals*, and another portion for the detection of the *acid*.

A. Detection of the Metals.

Table VI sets forth in a compact form the reactions of the metals with general reagents, and therefore serves as the chief guide to their detection. Whilst the course prescribed by it is easily understood with a little reflection, it is, however, absolutely necessary that the following rules be kept in view in the qualitative examination of complex compounds.

1. *The Precipitation by each of the General Reagents employed*

must be complete. The precipitant is therefore added gradually as long as a precipitate is produced by it, or with H_2S , until the liquid smells strongly of it *even after shaking*. The separation of the insoluble compound formed is promoted, in almost all cases, by gently warming the liquid. Some metallic oxides (As_2O_5 , MoO_3 , oxides of Pt, Ir, and Rh) are but slowly precipitated by H_2S , often only after warming the liquid, supersaturated with it, from twelve to twenty-four hours. (As_2O_5 much more rapidly however if heated to $60^\circ-70^\circ C.$)

2. *The precipitates which characterize the several groups must be completely freed from the members of the remaining groups, still in solution, by washing with water.* This is accomplished, according to circumstances, either upon a filter, or also in a test-tube by allowing the precipitate to subside and pouring off the clear liquid, and repeating the operation a number of times with fresh water. By carefully evaporating on platinum foil a portion of the filtrate from the precipitate of any group, not too small, the presence of members of the remaining groups may at once be ascertained. When easily oxidizable sulphides insoluble in dilute acids are present, some H_2S solution is added to the wash water, or in case of ferric and manganic sulphides a few drops of ammoniac sulphide, to prevent oxidation when the washing is prolonged.

By inattention to the two preceding conditions (complete precipitation and thorough washing), it is evident the members of the various groups may remain partially mixed with each other, and reactions may be obtained in the subsequent analytical operations which are not noticed in these tables, and which are inexplicable to the inexperienced.

3. *The mineral acid employed for acidulation of the liquid (if it is not already sufficiently acid) is either HCl , or HNO_3 , either dilute or concentrated, but not in such a quantity as to prevent the formation of insoluble sulphides.* The first is usually preferred, when the possible precipitation of $AgCl$, $HgCl$, $PbCl_2$, etc., as indicated in Table VI, must be considered.

4. If, in following the systematic course of qualitative analysis, the presence of one or more members of the different groups is recognized and proved by the reagents suggested in the tables, the analyst (especially the beginner) must make a series of confirmatory experiments with the original substance, or its separate constituents, which may control the results already obtained. Such experiments should never be omitted by the beginner, since

it is the principal aim of analytical exercises not only to become acquainted with the simple courses of analysis, but to become familiar with the deportment of a body in all its relations. Only by following this important rule will the less experienced be protected from errors and deceptions. For these continually arise from ignorance of the deportment of bodies, or the non-observance of the conditions upon which the result of an experiment—the appearance of the phenomenon which we regard as the proof of the presence of a substance—rests.*

The metals are further distinguished and separated according to Tables VII to X. [Or the course may be much simplified without sacrifice of accuracy, by proceeding according to Table XIV with the *filtrate* from the H_2S precipitate of Table VI, instead of treating it according to the method of that table.] C. F. H.

B. Detection of Acids or Representatives of them.

The qualitative analysis of acids is quite as simple as that of metals. In almost all cases the preliminary examination according to Tables I and XI, in connection with the quality of the metals previously detected, indicates in what class of acids, specially, tests are to be made. The knowledge of the deportment of a salt toward solvents, and the reaction of its aqueous solution with test-paper are especially important for this inference. By igniting the substance alone, as well as by heating it with concentrated sulphuric acid (according to Table XI), the presence of *organic* as well as *volatile inorganic* acids is ascertained. If there is reason to suspect the presence of several acids, or their salts, the circumstances must be considered, in the preliminary testing, which may possibly occasion deception, since changes may occur, or phenomena present themselves upon ignition or treatment with sulphuric acid different from those afforded by the several acids alone. Thus salts of organic acids, when mixed with nitrates or chlorates, decompose upon ignition without blackening, but generally with deflagration, and if sufficient organic matter is present no nitrate can then be detected after ignition, but only a carbonate, if the base is an alkali or alkaline earth. A mixture

* [The translation of the chapters of Prof. Wills' Outlines, which treat of the general deportment of bodies, has not been thought necessary, since the number of text-books, more or less complete, of that description with which these tables may be used, is perhaps sufficient, and it is also advisable for some reasons to refer the student to several of these, always kept accessible in the laboratory, rather than to confine his attention to one.] C. F. H.

of a nitrate with a chloride develops, on treatment with concentrated sulphuric acid, neither pure chlorhydric nor nitric acid, but chlorine and red nitrous vapors; in a mixture of a sulphite with a nitrate (chromate, chlorate, etc.) the sulphurous is converted into sulphuric acid; and sulphur is separated from most sulphides.

That the presence of volatile organic acids in an uncombined condition may not be overlooked, the acid solution is neutralized with sodic carbonate, evaporated and ignited, when organic acids will decompose with blackening, whilst they might otherwise be volatilized undecomposed.

For the detection of the more important acids in the wet way, in substances in solution, the course in Tables XII and XIII is followed. The use of *general* reagents for acids in most cases is only intended to determine the presence or absence of the members of a whole group of acids. The examination for the separate acids of these groups requires in addition the employment of the special tests of the tables.

If the examination for acids must take place in neutral liquids, acid solutions are neutralized with ammonia, alkaline ones with HNO_3 , or also with HCl if AgNO_3 is not to be used as a precipitant. If the compound was not originally soluble in water, but was soluble in acids without visible decomposition, and the base is an alkaline earth or an earth, then the acid solution (as in case of phosphates or oxalates of the alkaline earths) cannot be tested in a neutral condition by CaCl_2 , since, on neutralization with ammonia, the whole salt would be precipitated. In such cases (to which besides attention is directed in the precipitate of metallic oxides by $\text{H}_2(\text{NH}_4)\text{S}$), the test for the acids is made in acetic acid solutions, (with CaCl_2 for oxalic acid, and Fe_2Cl_6 for phosphoric acid), or the base is first removed in the proper way, (alkaline earths by H_2SO_4 , heavy metals by H_2S or $\text{H}_2(\text{NH}_4)\text{S}$). From the salts of organic acids, insoluble in water, the acids are removed by boiling with sodic carbonate, and the neutralized filtrate is tested with HCl . If a liquid, which contains H_2S , or a soluble sulphide, is to be tested for such acids as are precipitated from acid solutions by AgNO_3 but not by ferric salts ($\text{HCl}, \text{HBr}, \text{HI}$), the sulphur is removed by addition of ferric sulphate, and the filtrate acidified with HNO_3 is tested for these acids. Compounds insoluble in water and acids are decomposed according to Tables V and XII to be tested for acids.

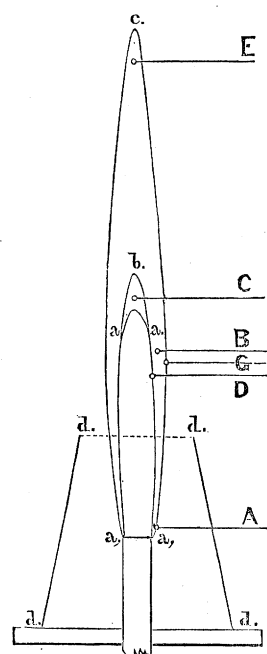
TABLE I.
PRELIMINARY EXAMINATION.

I. Behavior of Inorganic Substances and their Compounds in the Preliminary Experiments.

1. Easily volatilized when heated upon charcoal, (or upon platinum foil, or in a dry test-tube) :—	Compounds of ammonia and mercury , and several of arsenic , [and thallium], sulphur and its acids, water , etc. Carbon burns by ignition in the air; all organic compounds are decomposed when heated, most of them with the separation of carbon (blackening).						
2. Fusible without volatilizing, and without changing color :—	Most of the salts of the alkalis and some of the alkaline earths . After intense ignition in the reducing flame, they color turmeric paper brown. Some silicates , as Zeolites. Borates and alum swell up. Common salt and other salts, also many minerals, decrepitate. Of the reguline metals , <i>antimony, lead, thallium, cadmium, tellurium, bismuth, zinc, indium</i> , and <i>tin</i> , fuse easily before the blowpipe; <i>silver, copper</i> , and <i>gold</i> with more difficulty; the former metals at the same time give incrustations. (See below, 8, and Table III.)						
3. Deflagrate when heated upon charcoal :—	Nitrates, chlorates, perchlorates, iodates, bromates, etc.						
4. Infusible, or difficultly fusible, without changing color :—	The earths and their salts; the alkaline earths and their salts. When heated they glow with white light. After ignition the earths show no alkaline reaction. Silica , and many of its compounds. Of the reguline metals , iron, nickel, cobalt, molybdenum, tungsten, platinum, iridium, palladium, and rhodium are infusible before the blowpipe.						
5. Assume a darker color when heated :—	Many metallic oxides and their salts, as : zinc oxide , yellow (glows with yellowish-green light); stannic oxide, titanio acid, niobic acid , and antimonic acid , yellow; plumbic oxide, bismuthous oxide, chromates, mercuric oxide , etc., brown.						
6. Color the flame of a Bunsen gas-lamp, or the point of the blue flame of the blowpipe (upon platinum wire, or in case of metallic compounds upon charcoal) :—	<p>YELLOW.*</p> <p>Soda, or a mixture of salts of the alkalis.</p>	<p>VIOLET.</p> <p>Potassa, Rubidia, Cæsia.</p>	<p>CRIMSON.</p> <p>Lithia, Strontia.*</p>	<p>ORANGE.</p> <p>Lime.*</p>	<p>YELLOWISH-GREEN.</p> <p>Baryta,* Molybdic Acid.</p>	<p>GREEN.</p> <p>Cupric oxide,** Phosphoric Acid,† Boracic Acid,† Tellurous Acid. Compounds of Thallium.</p>	<p>BLUE.</p> <p>Arsenic, Antimony, Lead, Selenium, Cupric Chloride,** Indium.</p>
<p>* The colored flames are distinguished with most certainty by prismatic analysis.</p> <p>** Especially after moistening with chlorhydric acid, or the addition of argentic chloride, transitory.</p> <p>† In the salts after moistening with sulphuric acid.</p>							
7. Give, when moistened with a solution of cobalt, and strongly heated upon charcoal :—	<p>BLUE GLASS.</p> <p>Phosphates, Borates, Silicates, } of the Alkalies.</p>	<p>BLUE INFUSIBLE MASS.</p> <p>Alumina, and many of its compounds, Phosphates of the Earths, Silicic Acid and some Silicates of the Earths.</p>	<p>GREEN MASS.</p> <p>Zinc oxide, } Yellowish-green. Titanio Acid, } Bluish-green. Stannic oxide, } Muddy-green. Antimonic Acid, } Niobic Acid,</p>	<p>FLESH-RED MASS.</p> <p>Magnesia, Tantalio Acid.</p>	<p>BROWN OR BRICK-RED MASS.</p> <p>Baryta.</p>	<p>GRAY MASS.</p> <p>Glucina, Lime, Strontia.</p>	
8. Give, when ignited with sodic carbonate, (or sodic carbonate and potassic cyanide), in the reducing flame, upon charcoal :—	<p>GARLIC ODOR.</p> <p>Most of the Compounds of Arsenic.</p>	<p>HEPAR.*</p> <p>All compounds of sulphur (selenium, tellurium) without exception.</p>	<p>METALLIC GRAINS WITHOUT INCRUSTATION.</p> <p>Bright malleable spangles.</p> <p>Tin, white. Silver, white. Copper, red. Gold, yellow.</p>	<p>METALLIC GRAINS WITH INCRUSTATION.</p> <p>Metal brittle. Antimony, I. white, volatile. Bismuth, I. brownish-yellow.</p>	<p>METAL MALLEABLE.</p> <p>Lead, I. yellow. Thallium, Tarnishes, I. yellow. Indium, I. white.</p>	<p>INCRUSTATION WITHOUT METALLIC GRAINS.</p> <p>Zinc, white, not volatile in the outer flame. Cadmium, reddish-brown. Tellurium, white.</p>	
<p>* The mass when moistened blackens silver, and with acids, develops sulphuretted (seleniuretted or telluretted) hydrogen.</p>							
9. Give, when heated in a glass tube open at both ends, and held obliquely :—	<p>ODOROUS GASES.</p> <p>Metallic Sulphides,—of burning sulphur. " Selenides,—of decaying radishes. " Arsenides,—of garlic. Some ammoniaical compounds,—of ammonia. Metallic fluorides (upon addition of phosphorus salt).</p>	<p>METALLIC COATING.</p> <p>Some Arsenides. Some compounds of Mercury (especially with sodic carbonate).</p>	<p>WHITE COATING.</p> <p>Arsenides, crystalline. Antimonides, } fusible. Tellurides, } Plumbic sulphide. Some salts of ammonia.</p>	<p>FUSED SUBLIMATE.</p> <p>Higher sulphides, brownish-yellow. Selenides and selenium, dark red. (Also sulphide of arsenic.)</p>	<p>DROPS OF WATER.</p> <p>All hydrates (more distinct in a bulb tube).</p>		
10. In contact with zinc and chlorhydric (or sulphuric) acid color the fluid :—	<p>VIOLET OR LILAC.</p> <p>Titanio Acid.</p>	<p>BLUE.</p> <p>Tungstic and Vanadic Acids.</p>	<p>BLUE, THEN GREEN, AND DARK BROWN.</p> <p>Molybdic Acid.</p>	<p>BLUE, THEN MUDDY OR BROWN.</p> <p>Tantalio and Niobic Acids.</p>	<p>GREEN.</p> <p>Chromic Acid.</p>		

TABLE II.
PRELIMINARY EXAMINATION.

II. Flame Reactions* with the Bunsen Gas-lamp.



a, a, a, a, the dark nucleus.
a, c, a, b, the flame mantle. *a, b, a*, the luminous point not in the normal flame, but formed when needed by partially turning the collar.

Most of the tests described in Table I can be made more easily than with the blowpipe, by means of the non-luminous flame of a Bunsen gas-lamp, provided with a movable collar (by turning which the access of air may be regulated), and a conical chimney *d, d, d, d*. The flame should have the form of the annexed figure. The portions which serve for conducting the different reactions are distinguished as follows: 1. *Base of the flame, A*, having the lowest temperature; 2. *Zone of fusion, B*, having the highest temperature; 3. *Lower oxidizing flame, G*; 4. *Upper oxidizing flame, E*, the highest point of the non-luminous flame, (serves for cases of roasting and oxidation that do not require excessively high temperature). 5. *Lower reducing flame, D*, less

energetic than the following, and serving for reduction on charcoal, or in beads of fused salts; 6. *Upper reducing flame, C*, the luminous point formed on diminishing the supply of air, by partially closing the draught holes, by turning the collar. The test specimen is supported in the flame on a platinum wire, no thicker than a horse hair, or on a small fibre of asbestos, fastened in a small glass tube, and held by a suitable holder. The substances are tested, with very small specimens, in regard to:—

1. *Emission of light*, by holding in the hottest part of the zone of fusion. The emissive power is estimated as low, medium, or high, according as the luminosity of the specimen falls below, equals, or exceeds that of the platinum wire introduced at the same time.

2. *Fusibility*, which is expressed on a scale of temperature with the following six grades, distinguishable by the appearance of a thin platinum wire in different portions of the flame, as *below red heat, incipient red heat, red heat, incipient white heat, white heat, intense white heat*.

3. *Volatility*, by determining the time required to volatilize a weighed bead (0.01 gm.) in the zone of fusion, and comparing it with the time required to volatilize an equal weight of sodic chloride, the volatility of which is taken as unity.

4. *Flame coloration*, by placing the test specimen in the upper reducing flame. The coloration appears in the upper

oxidizing flame. Mixtures of substances are first tested in the base of the flame to obtain in the flame mantle (for an instant), the coloration produced by the more volatile, unmixed with that of the less volatile.

5. *Reduction and oxidation* in beads of fused salts. See Table IV.

6. *Reduction by charcoal or a metal*. This is accomplished, in the detection of *mercury, arsenic, phosphorus, sulphur, selenium, and tellurium*, by heating the thoroughly dried test-specimen in a thin glass tube† 3 cm. long, 2 to 3 mm. wide, to the point of fusion of the glass, with a mixture of sodic carbonate and carbon (soot from turpentine), or with a piece of magnesium wire, or of sodium. Reduction of other metallic compounds is effected, by first preparing a *small charcoal rod*, by coating a splinter (as an ordinary match) three-quarters its length with fused crystallized sodic carbonate, and charring it carefully in the flame, then placing the test-specimen, about the size of a mustard seed, mixed with a drop of fused sodic carbonate, upon the point of it, heating it to fusion in the lower oxidizing flame, and then passing it into the hotter portion of the lower reducing flame opposite. The products of reduction may then be further examined.

* See Bunsen's Flame Reactions, translated by the editor of these Tables, for fuller explanation and more complete list of special reactions.

† Forty of these may be made by drawing out an ordinary sized test-tube and cutting it with a diamond into lengths double the size of the tubes, and dividing these over the lamp and rounding the closed ends.] C. F. H.

TABLE III.
PRELIMINARY EXAMINATION.

III. Flame Reactions. (Incrustations.)

The incrustations, if collected on porcelain or glass, afford with further tests decidedly characteristic reactions. 1. **Metallic incrustations**, obtained by heating a very small particle of the substance on an asbestos fibre in the upper reducing flame (not too large, and perfectly free from smoke), and at the same time holding a glazed porcelain capsule, 0.1 metre in diameter, filled with water, immediately above it, on which any volatile metals present will be deposited, as a dark **incrustation**, surrounded by a thinner **coating** [often of a different tint]. On touching these with a drop of dilute nitric acid (containing 20 per cent. anhydride), on a glass rod, they are,

Instantly dissolved, Slowly and with difficulty attacked, Or unaffected,

Lead, cadmium, zinc, indium. *Bismuth, mercury, thallium.* *Tellurium, selenium, arsenic, antimony.*

2. **Oxide incrustation**, formed by holding the porcelain capsule, in the preceding experiment, at some distance from the test-specimen, in the upper oxidizing flame.* It is tested: (a) by touching it with drops of stannous chloride, and then with caustic soda; (b) by touching with drops of argentic nitrate solution, and blowing ammonia upon it.† 3. **Iodide incrustation**, formed by placing the oxide incrustation on the capsule [when cold], over a wide-mouthed vessel containing fuming HI (deliquesced phosphoric triiodide), and afterward gently warming it. It is tested by the moist breath (solubility), and by ammonia blown upon it.‡ 4. **Sulphide incrustation**, obtained from the last by blowing ammoniac sulphide upon it,‡ and then gently warming the capsule; characterized by its insolubility in water,§ color, and deportment with ammoniac sulphide (blown or dropped on it).

Volatile Elements Separable by Reduction as Incrustations.

	Metallic Incrustation and Coating.	Oxide Incrustation and Coating.	Oxide Incrustation with SnCl ₂ .	Oxide Incrustation with SnCl ₂ and NaHO.	Oxide Incrustation with AgNO ₃ and NH ₃ .	Iodide Incrustation and Coating.	Iodide Incrustation with NH ₃ (blown upon it).	Sulphide Incrustation and Coating.	Sulphide Incrustation with H(NH ₄)S.
Tellurium,	Black; with brown coating.	White.	Black.	Black.	White, tinged yellowish.	Brown; breathed upon disappears transitorily.	Disappears permanently.	Black to blackish-brown.	Disappears transitorily.
Selenium,	Cherry-red; with brick-red coating.	White.	Brick-red.	Black.	White.	Brown; breathed upon does not wholly disappear.	Does not disappear.	Yellow to orange.	Orange, then disappears transitorily.
Antimony,	Black; with brown coating.	White.	White.	White.	Black; insoluble in NH ₃ .	Orange; breathed upon disappears transitorily.	Disappears permanently.	Orange.	Disappears transitorily.
Arsenic,	Black; with brown coating.	White.	White.	White.	Lemon-yellow or brownish-red; soluble in NH ₃ .	Egg-yellow; breathed upon disappears transitorily.	Disappears permanently.	Lemon-yellow.	Disappears transitorily.
Bismuth,	Black; with soot-brown coating.	Yellowish-white.	White.	Black.	White.	Bluish-brown; with light red coating; breathed upon disappears transitorily.	Aurora-red to egg-yellow; chestnut brown when dry.	Umber-brown; with coffee-brown coating.	Does not disappear.
Mercury,	Gray, incoherent coating.					Carmine and lemon-yellow; breathed upon does not disappear.	Disappears transitorily.	Black.	Does not disappear.
Thallium,	Black; with brown coating.	White.	White.	White.	White.	Lemon-yellow; breathed upon does not disappear.	Does not disappear.	Black; with bluish-gray coating.	Does not disappear.
Lead,	Black; with brown coating.	Light ochre yellow.	White.	White.	White.	Egg-yellow to lemon-yellow; breathed upon does not disappear.	Disappears transitorily.	Through brownish-red to black.	Does not disappear.
Cadmium,	Black; with brown coating.	Brownish-black; with white coating.	White.	White.	Coating becomes blue-black.	White.	White.	Lemon-yellow.	Does not disappear.
Zinc,	Black; with brown coating.	White.	White.	White.	White.	White.	White.	White.	Does not disappear.
Indium,	Black; with brown coating.	Yellowish-white.	White.	White.	White.	Yellowish-white.	Yellowish-white.	White.	Does not disappear.

* With a small quantity of the substance the lamp should be suitably turned down so that the coating may not be spread over too much surface.
 † By blowing through ammonia water in a small wash bottle, with exit tube just below the cork. It may also be treated with drops of ammonia.
 ‡ By an apparatus similar to that for ammonia. See †. § Generally insoluble in the breath, but possessing different degrees of solubility in drops of water.] C. F. H.

TABLE IV.
PRELIMINARY EXAMINATION.

IV. Behavior of Metallic Oxides before the Blowpipe with Sodic ammonic hydric Phosphate (Phosphorus Salt), and Borax.

The bead (formed on a loop of platinum wire, or, in experiments with the reducing flame, also upon charcoal) is gradually saturated with the finely-powdered substance. In using the non-luminous gas-flame, the bead fused on a platinum wire as thick as a horse-hair, is introduced by means of a holder into the *lower reducing*, or into the *lower oxidizing flame*. (Compare Table II.) The colors of the beads frequently differ, according to their temperature, and to the quantity of the dissolved oxide. (The following abbreviations are—h. hot, c. cold, h. c. hot and cold, f. s. feebly saturated, s. s. strongly saturated.)

COLOR OF THE BEADS.	With Phosphorus Salt.		With Borax.	
	<i>In the Oxidizing Flame.</i>	<i>In the Reducing Flame.*</i>	<i>In the Oxidizing Flame.</i>	<i>In the Reducing Flame.</i>
COLORLESS:—	<i>Silica gives skeleton of silica. Alumina, stannic oxide.—h. c. all alkaline earths, and earths (s. s. not clear). Tantalum, niobic, titanic, tungstic acids, zincic, cadmic, plumbic, bismuthous, antimonious oxides (f. s.); s. s. yellowish.</i>	<i>Silica gives skeleton of silica. Alumina. All alkaline earths and earths (s. s. not clear), ceric, didymic, manganic, and stannic oxide.</i>	<i>h. c. Silica, alumina, stannic oxide. h. c. (s. s. not clear); all alkaline earths and earths, argentic oxide, tantalum, niobic, and tellurous acid.—f. s. Titanic, tungstic, and molybdic acid, zincic, cadmic, plumbic, bismuthous, and antimonious oxide.</i>	<i>h. c. Silica, alumina, stannic oxide—h. c. (s. s. not clear); all alkaline earths and earths, lanthanum oxide, ceric oxide, tantalum acid.—h. c. Manganic oxide, didymic oxide. h. Cupric oxide.</i>
YELLOW:— (to brown).	<i>h. (f. s.) Ferric oxide, ceric oxide.—h. Vanadic acid, uranic oxide, argentic oxide.—c. Nickelous oxide.</i>	<i>h. Ferric oxide (yellow to red), titanic acid.</i>	<i>h. Ferric oxide, uranic oxide (f. s.). h. Vanadic acid. h. Plumbic, bismuthous, and antimonious oxide (s. s.).</i>	<i>h. Tungstic acid. (h. Titanic, vanadic, and molybdic acid yellow to brown.)</i>
RED:—	<i>h. (s. s.) Ferric oxide, ceric oxide. h. Nickelous oxide, chromic oxide.</i>	<i>h. Ferric oxide. c. Titanic and tungstic acid, containing iron (blood-red).</i>	<i>h. Ceric, and ferric oxide. c. Nickelous oxide (reddish-brown).</i>	<i>c. Cupric oxide (opaque s. s.).</i>
VIOLET:— (Amethyst).	<i>h. c. Manganic oxide, didymic oxide.</i>	<i>c. Titanic acid, niobic acid (s. s.)</i>	<i>h. c. Manganic, and didymic oxide. Nickelous oxide containing cobalt.</i>	
BLUE:—	<i>h. c. Cobaltous oxide. c. Cupric oxide.</i>	<i>h. c. Cobaltous oxide. c. Tungstic acid, niobic acid (s. s.)</i>	<i>h. c. Cobaltous oxide. c. Cupric oxide.</i>	<i>h. c. Cobaltous oxide.</i>
GREEN:—	<i>h. Cupric oxide, molybdic acid. c. Chromic oxide, uranic oxide. h. Ferric oxide containing cobalt or copper.</i>	<i>c. Chromic oxide, uranic oxide, vanadic acid, molybdic acid.</i>	<i>c. Chromic oxide, vanadic acid. h. Cupric oxide, ferric oxide, containing cobalt or copper.</i>	<i>h. c. Ferric, uranic, and chromic oxide, c. Vanadic acid.</i>
GRAY:— (dull).		<i>c. Argentic, zincic, cadmic, plumbic, bismuthous, and antimonious oxide, tellurous acid, nickelous oxide.</i>		<i>As with phosphorus salt. Also niobic acid (s. s.).</i>

* Reduction generally takes place more easily with phosphorus salt. In case of ferric oxide, titanic, and tungstic acid, the reduction is hastened by the addition of a very small quantity of tin to the test specimen (upon charcoal).

TABLE V.
FLUXING.

V. Conversion of Insoluble Compounds into Soluble.

If a finely pulverized compound, after being successively treated with *water, dilute and concentrated chlorhydric acid, nitric acid, and aqua regia*, remains undissolved, or is not decomposed or attacked by the acids in such a way as to afford decisive conclusions as to the nature of the insoluble compound, then the latter must be *made soluble by fluxing*, in order that its constituents may be determined in the humid way. The mode of fluxing in many cases depends upon the result of the preliminary examination; the latter should therefore be conducted with great care. If no *decisive* indication for the treatment of the insoluble compound according to this table be given, then it is always to be fused in form of fine powder with four parts of mixed sodic and potassic carbonates, and the fused mass treated with water, and the washed residue with chlorhydric acid. Platinum crucibles should never be employed for *any* substances containing *arsenic* or any *easily reducible metal* (antimony, tin, lead, bismuth, etc.).

a. Sulphates. (<i>Baric, strontic, and plumbic Sulphates.</i>)	b. Silicic Acid and Silicates.	c. Fluorides. (<i>Fluorspar, etc.</i>)	d. Alumina or Aluminates.	e. Chromic Oxide. (<i>Chromic Iron.</i>)
<p>With sodic carbonate upon charcoal they give <i>Hepar</i>. <i>Baric and strontic sulphates</i> are decomposed by fusing with 4 parts of alkaline carbonate. After treatment with water and washing, the solution contains the <i>acid</i>, the residue the <i>base</i> (now soluble in chlorhydric acid). <i>Plumbic sulphate</i> gives a metallic grain with sodic carbonate, is blackened by ammonic sulphide, and dissolves in ammonic tartrate with excess of ammonia. <i>Gypsum</i> is somewhat soluble in water.</p>	<p>Give with phosphorus salt <i>skeleton of silica</i>. The solution of the decomposable silicates is effected by chlorhydric acid; of the undecomposable by fusion with 3—4 parts of alkaline carbonate (or baric hydrate), treatment with <i>chlorhydric acid</i>, and separating the silicic acid by evaporation with free chlorhydric acid. Or by means of fluohydric acid. The substance must always be very finely powdered.</p>	<p>With concentrated sulphuric acid they give <i>fluohydric acid gas</i>, which etches glass; in presence of silicic acid, silicic fluoride, which gives a precipitate with water. The solution is effected by fusing with 4 parts of alkaline carbonate (completely by addition of silica) and boiling with water. The solution contains the <i>acid</i>, the washed residue the <i>base</i> (now soluble in chlorhydric acid).</p>	<p>When ignited with solution of cobalt they give a <i>blue</i>, infusible mass. The solution is effected by fusing with 3 to 4 parts of hydric potassic, or hydric sodic sulphate (or also of carbonate), and treating with water, or chlorhydric acid. [See note, Table XIV.]</p>	<p>Gives with phosphorus salt and borax green beads in the outer and inner flame. The solution is effected by fusing with hydric potassic sulphate, or a mixture of potassic nitrate (or chlorate), and alkaline carbonate. Chromic iron, very finely powdered, requires successive treatment by both methods; the mass resulting from the last fusion with alkaline carbonate (and the oxidizing agent) contains the chromium as alkaline chromate, soluble in water. [See also note, Table XIV.]</p>
<p>f. Stannic Oxide, or Antimonic Acid.</p> <p>With sodic carbonate upon charcoal they give malleable or brittle metallic grains, and are colored by ammonic sulphide. By fusion with 3—4 parts alkaline carbonate they become soluble in acids. They are also soluble in excess of yellow ammonic sulphide. Moistened with chlorhydric acid in contact with zinc, in a platinum capsule, they are reduced to metals.</p>	<p>g. Titanic, Tungstic, Tantalic, Niobic Acid.</p> <p>With phosphorus salt they give a <i>blue, violet</i>, or (those containing iron) <i>blood-red</i> bead, and with zinc and chlorhydric acid a coloration. The solution is effected by fusing with 6 parts of hydric potassic, or hydric sodic sulphate (or also of carbonate). [See note to Table XIV.]</p>	<p>h. Chlorides (<i>Argentive Chloride, Bromide, Iodide</i>). Sulphides (<i>Molybdic Sulphide, etc.</i>)</p> <p><i>Argentive chloride, bromide, and iodide</i> give with sodic carbonate a silver granule. The decomposition is effected by means of zinc and dilute sulphuric acid, or by fusing with lime or alkaline carbonate, the metal being separated. <i>Plumbic sulphide</i> gives a metallic granule, and with nitric acid, plumbic sulphate. (See a) <i>Molybdic sulphide</i> gives, with phosphorus salt, yellowish-green beads, and is changed by roasting into molybdic acid, becoming blue with zinc and chlorhydric acid.</p>	<p>i. Reguline metals. (<i>Osmiridium, or residue of platinum ores.</i>)</p> <p>The insoluble mass has metallic lustre or is black, pulverulent, and not changeable by ignition. The solution is effected by igniting the powder, mixed with common salt, in chlorine gas, or by fusing with a mixture of potassic hydrate and potassic chlorate.</p>	<p>k. Carbon.</p> <p>The insoluble mass is black (as diamond, also colorless), and disappears when subjected to great heat in an open platinum crucible, or before the blowpipe. It deflagrates when fused with potassic nitrate with the formation of potassic carbonate, and when ignited with cupric oxide (in case of graphite in a stream of oxygen), gives carbonic acid.</p>

TABLE VI.
DETECTION OF METALLIC OXIDES.

VI. Department of Solutions of Metallic Oxides with Chlorhydric Acid, Sulphydric Acid, Ammonic Sulphide (Ammonia), and Ammonic Carbonate, used successively.

Chlorhydric Acid.	Sulphydric Acid.		Ammonic Sulphide.			Ammonic Carbonate.		
<i>Oxides which are precipitated from a neutral or acid solution by chlorhydric acid, as chlorides.*</i>	<i>Oxides which are partially reduced in an acid solution whilst sulphur is precipitated.*</i>	<i>Oxides which are precipitated by sulphydric acid from their solutions, acidulated by chlorhydric or nitric acid, as sulphides.</i>	<i>Oxides which are precipitated from neutral solutions, by ammonic sulphide (in the presence of ammonic chloride). (The solution should be supersaturated with ammonia before the addition of the ammonic sulphide.)</i>			<i>Oxides, which are neither precipitated by sulphydric acid, nor by ammonic sulphide, are by ammonic carbonate, in the presence of ammonic chloride.</i>		
Plumbic oxide , white, crystallizable; soluble in much water, precipitable by sulphuric acid. Argentio oxide , white, curdy; soluble in ammonia, whence it is precipitable by nitric acid. Mercurous oxide , white, pulverulent; is blackened by ammonia. [Thallious oxide], white, curdy; more completely precipitated by potassic iodide.	Ferric oxide , the fluid is decolorized, and contains ferrous oxide. Manganic oxide , Permanganic acid , the fluid becomes colorless, and contains manganous oxide. Chromic acid , the fluid becomes green, and contains chromic oxide.	<i>Soluble in Ammonic Sulphide.</i> Antimonious oxide , } orange. Antimonic acid , } Arsenious acid , } yellow. Arsenic acid , } low. Stannous oxide , brown. Stannic oxide , yellow. Auric oxide , } blackish-brown. Platinic oxide , } Iridic oxide , } [Oxides of Molybdenum], * brown. [Selenious acid], red dish-yellow. [Tellurium acids], black.	<i>Insoluble in Ammonic Sulphide.</i> Mercurous oxide , } Mercuric oxide , * } Argentio oxide , } black. Plumbic oxide , ** } Cupric oxide , } Cadmio oxide , yellow. } Bismuthous oxide , brown. } [Oxides of palladium], } [Oxides of osmium], } [Oxides of rhodium], } [Ruthenic oxide], *** } black or brown.	<i>As Sulphides.*</i> Nickelous oxide , } Cobaltous oxide , } Ferrous oxide , } black. Ferric oxide , } Uranous oxide , } blackish-brown. Uranic oxide , } Manganous oxide , } flesh-red. } Zincio oxide , white. } [Indic oxide], ** } yellowish. [Thallious oxide], ** } black.	<i>As Oxides:</i> also precipitable by ammonia. <i>As Salts.*</i> also precipitable by ammonia. a. Soluble in Potassa. Alumina , * } colorless. [Glucina], } Chromic oxide , green. } [Tantalio acid], ** } [Niobio acid]. } b. Insoluble in Potassa. [Cerous oxide], } [Lanthanic oxide], } [Didymic oxide], } [Yttria], } [Zirconia], } [Thoria], } [Titanic acid], } mostly colorless or white.	<i>As Salts.*</i> also precipitable by ammonia. a. In presence of Phosphoric Acid. Magnesia , crystalline. b. In the presence of Phosphoric or Oxalic Acid. Lime , } Strontia , } white. Baryta , } as phosphates or oxalates.	<i>precipitated.*</i> white. Baryta . Strontia . Lime . as carbonates.	<i>not precipitated:</i> a. Precipitable by Hydric-disodic Phosphate (and Ammonia). Magnesia , (crystalline.) b. Not precipitable by Sodico Phosphate. Potassa . Soda . [Lithia].* [Cæsia]. [Rubidia]. Ammonia .
<small>* In an alkaline solution hydrochloric acid (and also nitric acid) may cause a precipitate when any of the following are present:— <i>Silicic acid</i>, <i>Boracic acid</i>, <i>Antimonic acid</i>, <i>Tungstic acid</i>, <i>Molybdic acid</i>, farther oxides soluble in alkalies (<i>plumbic oxide</i>, <i>alumina</i>, in excess, soluble in nitric acid) as well as <i>metallic cyanides</i> and <i>ferrocyanides</i> and all <i>metallic sulphides</i> and all <i>ammonic sulphide</i>. A precipitate of sulphur may also be formed in soluble polysulphides and hypsulphites.</small>	<small>* A precipitation of sulphur may also occur by the presence of free chlorine, bromine, iodine, sulphurous, nitrous, hypochlorous, chloric, bromic, or iodic acid, etc., or generally by the presence of any of the easily reducible higher oxides which are not precipitated as sulphides from acid solutions.</small>	<small>* The oxides of tungsten and of vanadium are precipitated as sulphides only when their solution, mixed with ammonic sulphide is decomposed by an acid. The solution of SnS₂ in ammonic sulphide is precipitated by acids, yellow, as SnS₂.</small>	<small>* The oxide of mercury is precipitated white or yellowish by a little sulphydric acid, by an excess of the acid, black. ** Oxide of lead is only completely precipitated by sulphydric acid out of dilute, and not too acid solutions. *** The platinum metals are precipitated with difficulty by H₂S.</small>	<small>* Zincio sulphide is insoluble in acetic acid. Cobaltous and nickelous sulphide are with difficulty soluble in dilute chlorhydric acid, and in acetic acid; nickelous sulphide is slightly soluble in yellow ammonic sulphide (containing ammonia) with a brown color. ** Thallium and Indium are not noticed further in these tables, (traces of them only occur, and they are easily detected by the spectroscopie).</small>	<small>* In presence of phosphoric acid, also aluminic phosphate. ** Soluble after being fused with potassic hydrate.</small>	<small>* The phosphates of the alkaline earths are insoluble in potassa, and soluble in acetic acid; the calcic oxalate is also insoluble in acetic acid. Aluminic phosphate is soluble in potassa.</small>	<small>* The precipitation is only complete in the presence of ammonia and upon heating the solution to boiling.</small>	<small>* Lithia is only precipitated from concentrated solutions, upon heating by Hydro-disodic phosphate.</small>

TABLE VII.
DETECTION OF METALLIC OXIDES.

VII. Treatment of the Precipitate formed by Sulphydic Acid in Warm Acid Solution.

A portion of the washed precipitate is digested with ammoniac sulphide (with potassic sulphide if copper be present), filtered, if there be a residuum, and to the liquid, dilute sulphuric acid is added. (If the solution be partial, the remaining portion of the precipitate is subjected to the same treatment; if it be complete this is not necessary.) If the precipitate formed by dilute sulphuric acid be not *white, milky* (of sulphur alone), but *flocculent*, and more or less *colored*, it (or the original precipitate, if it is entirely soluble in ammoniac sulphide) is treated according to A.—The precipitate insoluble in ammoniac sulphide is examined according to B.

A. The Portion soluble in Ammoniac Sulphide.

<p>The <i>yellow or orange-red</i> precipitate (containing arsenious, stannic, or antimonious sulphide, or a mixture of them) is gently warmed with a concentrated solution of ammoniac carbonate, and the solution filtered.*</p>		<p>The <i>brown or brownish-black</i> precipitate may contain:</p>
<p>(a.) Solution contains: <i>Arsenious</i> (a little <i>stannic</i>) <i>sulphide</i>.</p> <p>Add some H₂S solution, supersaturate with chlorhydric acid, and warm; dissolve the separated sulphide in fuming nitric acid, or in chlorhydric acid and (a little) potassic chlorate. When arsenic is present, a precipitate is formed in the solution (after it has been supersaturated with ammonia, and filtered from any separated stannic oxide), by a mixture of magnesian sulphate, ammoniac chloride, and ammonia. Traces of arsenic are detected by converting into AsH₃ in Marsh's apparatus (arsenic spots disappear in sodic hypochlorite).</p>	<p>(b.) Residue contains: <i>Antimonious sulphide, stannic sulphide</i>.</p> <p>Dissolve the sulphide in chlorhydric acid and (a little) potassic chlorate, and test the solution for:—</p> <ol style="list-style-type: none"> 1. <i>Antimony</i>, by bringing several drops in contact with a fragment of zinc on platinum foil (antimony produces a deep black stain); or by formation of SbH₃ (antimony spots do not dissolve in sodic hypochlorite, and are blackened by ammonio-nitrate of silver, after oxidation by dilute nitric acid cautiously evaporated). 2. <i>Tin</i>, by warming the solution with zinc, dissolving the precipitated black metallic powder, washed off of the undissolved zinc, in warm chlorhydric acid, and adding mercuric chloride to the solution. (A white or gray precipitate indicates tin.) 	<p><i>Cupric sulphide</i> (traces), <i>Platinic sulphide</i>, <i>Iridium sulphides</i>, <i>Auric sulphide</i>, <i>Tellurium sulphides</i>, <i>Molybdenum sulphides</i>, <i>Tungstic sulphides</i>, <i>Vanadium sulphides</i>,</p> <p>To be detected, if their presence is suspected, by the methods of the preliminary examination.</p>
<p>* By treatment of the sulphides with concentrated chlorhydric acid, with aid of heat, arsenious sulphide remains undissolved (to be further tested according to (a)), whilst the solution may be tested for antimony and tin (according to (b)). The separation is more complete by digesting the solution of the sulphides in potassic sulphide with excess of sulphurous acid, finally expelling the latter by boiling; the arsenic alone will remain in solution, as an arsenite.</p>		

B. The Portion insoluble in Ammoniac Sulphide.

<p>The well-washed precipitate is treated by aid of heat, with concentrated <i>nitric acid</i> (free from chlorine). It is either <i>fully dissolved</i>, or there is a <i>residue</i>. If the original fluid (before precipitation by sulphydric acid), was acidulated with chlorhydric acid, then this precipitate can contain no argentic sulphide, and no sulphide of mercury arising from mercurous oxide (though it might from mercuric oxide) and a little plumbic sulphide. Osmium, rhodium, and ruthenium need only be considered in the investigation of platinum ore.</p>					
<p>Residue may consist of:</p>			<p>Solution may contain: Plumbic, argentic, bismuthous, cupric, cadmic, [and palladious] oxide. <i>Dilute sulphuric acid is added to it.</i></p>		
<p><i>Sulphur.</i> Yellow or gray, flocculent, or balled up, often inclosing metallic sulphides.</p>	<p><i>Mercuric sulphide.</i> Black, flocculent.—The solution in aqua regia, somewhat evaporated, is precipitated by stannous chloride.</p>	<p><i>Plumbic sulphate.</i> White, pulverulent, soluble in ammoniac tartrate with excess of ammonia.</p>	<p><i>Chlorhydric acid is added to the filtrate:—</i></p>		
<p>If sulphide of mercury is found, the original fluid is tested for <i>mercuric</i> and <i>mercurous oxide</i>. <i>Chlorhydric acid is added to the fluid.</i></p>			<p><i>Precipitate.</i> Plumbic sulphate. Soluble in ammoniac tartrate with excess of ammonia; thence it is precipitated by potassic chromate.</p>	<p><i>Precipitate.</i> Argentic chloride. Soluble in ammonia, it is reprecipitated by nitric acid.</p>	<p><i>The filtrate is supersaturated with ammonia:—</i></p>
<p><i>Precipitate.</i> Mercurous chloride Becomes black with ammonia or potassa.</p>	<p><i>Filtrate.</i> Mercuric chloride. Excess of stannous chloride precipitates metallic mercury; recognized by rubbing on clean copper.</p>	<p><i>Precipitate.</i> Bismuthous oxide. Its solution in a little chlorhydric acid acquires a whitish turbidity with water, a black with stannous oxide in potassa.</p>	<p><i>The filtrate may contain:—</i></p>		
			<p>Cupric oxide. The <i>blue</i> ammoniacal solution is (after acidulation), precipitated reddish-brown by potassic ferrocyanide.</p>	<p>Cadmic oxide. The <i>colorless</i> ammoniacal solution is precipitated <i>yellow</i> by sulphydric acid.</p>	<p>[Palladious oxide.] The original (<i>brown</i>) fluid is precipitated black by potassic iodide.</p>
<p>For the recognition of cadmic oxide in presence of cupric oxide, potassic cyanide is added to the blue ammoniacal solution, until the color vanishes; then only cadmium is precipitated by sulphydric acid. Or the precipitated sulphides are heated to boiling with dilute sulphuric acid, in which case only the cadmium is dissolved.</p>					

TABLE VIII.
DETECTION OF METALLIC OXIDES.

VIII. Treatment of the Precipitate formed by Ammonic Sulphide, or Ammonia, in presence of Ammonic Chloride.

[For a different treatment compare Table XIV., and notes. C. F. H.]

If *nickel* is present the filtrate, from the ammonic sulphide precipitate, is brown. *After being washed*, the precipitate is treated upon the filter with warm dilute chlorhydric acid, the resulting solution is heated with (not too much) nitric acid or potassic chlorate, in order to remove the sulphydric acid and to convert any ferrous salt that may be present into a ferric salt. If, upon dissolving the ammonic sulphide precipitate in chlorhydric acid, a black residue remain (CoS or NiS), it is first to be tested before the blowpipe for cobalt, then dissolved in aqua regia, and the solution added to the chlorhydric acid solution. (If but *one* base is to be sought for, the original fluid may also be employed for testing according to this table. It serves also for determining, when iron is present, whether it appears as ferrous or ferric oxide.)

The Solution is strongly supersaturated with Caustic Potassa, the Precipitate, if one remain, gently digested, and filtered.			
The Fluid or Filtrate may contain :*—		The Precipitate may contain :—	
Chromic oxide, zincic oxide, alumina, aluminic phosphate, [glucina]. Boil the (green) potassa solution for some time.		Cobaltous, nickelous, manganous, ferric, and uranic oxide; baric, strontic, calcic, and magnesian phosphate; calcic oxalate; calcic fluoride; [all rare earths insoluble in potassa]. (Also alumina and chromic oxide with magnesia and zincic oxide; zincic oxide with ferric oxide.*) Dissolve the washed precipitate in a little chlorhydric acid, add ammonic chloride and ammonia.	
<i>Precipitate :</i> Chromic oxide. (Also glucina and zincic oxide.) Test by the blowpipe.	<i>Filtrate may contain :—</i> Zincic oxide, Alumina, Aluminic phosphate,* [Glucina].	<i>Filtrate may contain :*—</i> Cobaltous, nickelous, and manganous oxide, (zincic oxide, magnesia.) Precipitate the fluid, <i>slightly</i> acidulated with acetic acid, with sulphydric acid, <i>by aid of heat</i> .	<i>Precipitate may contain :—</i> Ferric and uranic oxide; baric, strontic, calcic, and magnesian phosphate; calcic oxalate; calcic fluoride; [all rare earths;] (also alumina, chromic and manganic oxide). Digest the precipitate with concentrated solution of ammonic carbonate.†
To one part, <i>Sulphydric acid</i> .	To the other (after supersaturating with <i>chlorhydric acid</i>), <i>Ammonic carbonate</i> .	<i>Precipitate :</i> Cobaltous sulphide. Nickelous sulphide, (Zincic sulphide). Test for cobalt by the blowpipe, or by potassic nitrite; for nickel by mixing the liquid, heated with excess of potassic cyanide, with sodic carbonate and hypochlorite.†	<i>Residue may contain :—</i> Ferric oxide; baric, strontic, calcic, and magnesian phosphate; calcic oxalate, (and fluoride). Dissolve in a little chlorhydric acid, and test the solution in separate portions for :— a. <i>Ferric oxide</i> (with potassic ferrocyanide). b. <i>Baryta and strontia</i> (with solution of gypsum). c. <i>Lime</i> (with potassic oxalate and sodic acetate). d. <i>Magnesia</i> (add sodic acetate, then ferric chloride until reddish color is produced, heat to boiling, precipitate the filtrate with ammonic carbonate, and test with sodic phosphate). e. <i>Phosphoric acid</i> (add, <i>whilst cold</i> , sodic acetate, then a <i>drop</i> of ferric chloride; or with ammonic molybdate). f. <i>Oxalic acid</i> (calcic oxalate is precipitated white by sodic acetate; the precipitate is insoluble in acetic acid, and is changed by ignition into calcic carbonate).* g. <i>Fluorine</i> (with the original substance.)
<i>Precipitate :</i> Zincic sulphide.	<i>Precipitate :</i> Alumina, aluminic phosphate, [glucina]. (Test by the blowpipe. Glucina is soluble in ammonic carbonate.)	<i>Filtrate :</i> Manganous oxide (Magnesia). Evaporate to dryness, and test the residue by fusing with sodic carbonate and nitre upon platinum foil. A bluish-green mass indicates manganese. Or test the original substance with plumbic peroxide and nitric acid.	<i>Solution may contain :—</i> Uranic oxide,* Cerous oxide, Lanthanic oxide, Didymic oxide, } ** Yttria, Thoria, Zirconia, }
* Chromic and zincic oxide cannot both be present in the alkaline solution at the same time, as in that case, they form the compound ZnOCr ₂ O ₃ insoluble in potassa. Chromic and ferric oxides are successively precipitated according to their relative quantities. Out of a solution which contains magnesia in connection with alumina or chromic oxide, a part of the magnesia is always precipitated by ammonia or ammonic sulphide with those oxides as a gelatinous compound insoluble in potassa. They are separated by boiling with NH ₄ Cl, or by dissolving repeatedly in HCl and precipitating by NH ₄ O in presence of much NH ₄ Cl; the separation of chromic oxide, the presence of which in the residue insoluble in potassa is easily recognized by the blowpipe (by the green color of the bead), from magnesia, zincic and ferric oxide, and alumina is more perfectly effected by fusion with potassic carbonate and nitrate or by heating the precipitate with sodic hypochlorite. For the detection of a small quantity of alumina in connection with ferric oxide, the precipitate by ammonic sulphide is boiled with potassa, the filtrate supersaturated with HCl and the clear liquid neutralized by ammonic carbonate. The detection of phosphoric acid in connection with alumina is effected by ammonic molybdate.			
† If nickel be present, a flocculent, deep black precipitate forms, after some time in the cold, or immediately on gently warming, which must be tested by the blowpipe. Potassic nitrite precipitates, from the slightly acid solution, yellow potassic-cobaltic nitrite.			
* When uranic oxide is present, the solution, after supersaturation with chlorhydric acid, gives a brown precipitate with potassic ferrocyanide. ** They almost all form with potassic sulphate difficultly soluble double salts. † Digestion with ammonic carbonate is only employed when there is reason to examine for rare oxides.			
* Also ferric phosphate is, <i>when cold</i> , precipitated from the chlorhydric acid solution (made as neutral as possible) by sodic acetate. (Yellowish, flocculent, or gelatinous.)			

IX. Precipitate by Ammonic Carbonate in presence of Ammonic Chloride and Free Ammonia.

Baric, Strontic, Calcic Carbonate, or a mixture of them.

The washed precipitate is dissolved upon the filter in a little chlorhydric acid [or in acetic acid if the Second Method below is to be used], and the solution divided into three portions. If only one base is to be sought the original solution can also be employed for this purpose.

I. Portion.	II. Portion.	III. Portion.	[Second Method. C. F. H.]	Remarks.
<p>Add <i>calcic sulphate</i>.</p> <p>Immediate precipitation:</p> <p>Baryta.</p> <p>Turbidity after some time:</p> <p>Strontia.</p> <p>Fluid remains clear:</p> <p>Lime.</p>	<p>Precipitate with excess of dilute sulphuric acid,* supersaturate the filtrate with ammonia, and add potassic [or ammonic] oxalate.</p> <p>Precipitate insoluble in acetic acid.</p> <p>Lime.</p> <p>* In the absence of baryta and strontia precipitation by sulphuric acid is unnecessary.</p>	<p>a. <i>When baryta is present.</i>—Evaporate to dryness, digest the residue with alcohol, and ignite the filtrate.</p> <p><i>Crimson flame:—</i></p> <p>Strontia.</p> <p>b. <i>When baryta is absent.</i>—Strontia is also recognized with certainty, since the solution in chlorhydric acid, by addition of solution of strontic sulphate, does not become turbid, even after a long time, whilst with calcic sulphate it gives a precipitate in a short time.</p>	<p>Dissolve the precipitate by ammonic carbonate in dilute acetic acid, and add to the solution neutral potassic chromate.</p> <p><i>Precipitate (yellow).</i> Baryta.</p> <p>Supersaturate the filtrate with ammonia, and add ammonic carbonate, wash the precipitate (strontia and lime), dissolve in a little acetic acid, and to a portion of the solution add, not too little, calcic sulphate.*</p> <p><i>Turbidity after some time.</i> Strontia.</p> <p>Precipitate the strontia from another portion by dilute sulphuric acid, filter, supersaturate the filtrate (or acetic acid solution, if strontia be absent) with ammonia, and add ammonic oxalate.</p> <p><i>Precipitate (insoluble in acetic acid).</i> Lime.</p>	<p>If no metallic oxide precipitable by sulphydric acid or ammonic sulphide be present, the original solution may also be used for these tests (except of Portion III. a), magnesia or alkalies not interfering with the result.</p> <p><i>Baryta</i> is also recognized with certainty in presence of strontia and lime, by a solution of strontic sulphate, which causes a white precipitate, appearing only after a time with traces of baryta. Separation of baryta from strontia is effected by hydrofluosilicic acid, with addition of alcohol, in which baric silicofluoride is quite insoluble. The alkaline earths may also be detected by the spectroscope.</p>
<p>* Or add not too little dilute solution of potassic sulphate (1 part by weight to 200 by measure of water). <i>Turbidity after some time, Strontia.</i> Add to the liquid dilute sulphuric acid, filter, supersaturate the filtrate (or liquid if no turbidity was produced by potassic sulphate) with ammonia, and add ammonic oxalate. Precipitate (insoluble in acetic acid), <i>Lime.</i></p>				

X. Fluid which is Precipitated neither by Sulphydic Acid, Ammonic Sulphide, nor Ammonic Carbonate.

It may contain:—*Magnesia, Potassa, Soda, Lithia, Rubidia, Cæsia, Ammonia, or a mixture of these bases.*

Evaporate a portion (not too small) of the fluid upon platinum foil; if after ignition there is no residuum, neither magnesia nor alkalies need be considered, but ammonia should be.

Test for Ammonia.	Test for Magnesia.	Test for Potassa, Soda, Lithia, Rubidia, and Cæsia.
<p>Warm the original substance or its solution (not the fluid, X.) with calcic hydrate.</p> <p>The presence of <i>Ammonia</i></p> <p>is recognized by the odor, as well as by the white cloud which arises when a glass rod moistened with chlorhydric acid is brought near.</p> <p>Slight traces may be detected by condensing the vapor, developed by calcic hydrate, in a test-tube, and adding to it an alkaline solution of mercuric iodide in potassic iodide; ammonia producing a brownish-red precipitate.</p>	<p>Add sodic phosphate (and free ammonia if not already present) to a portion of the fluid X. (or to the original solution if it contain no metallic oxides or alkaline earths).</p> <p>The presence of <i>magnesia</i> is manifested by a crystalline precipitate, which forms slowly when only traces of magnesia are present. (If the separation of the alkaline earths by ammonia and ammonic carbonate did not take place at a boiling heat, sodic phosphate will always give a small, flocculent precipitate of a phosphate of an alkaline earth.)</p>	<p>a. <i>When magnesia is absent.</i> Evaporate fluid X. (to which no sodic phosphate has been added) to dryness, ignite gently (to remove the ammonic salts), test the residue before the blowpipe upon platinum wire, or by overflowing with alcohol and igniting. A violet flame indicates presence of potassa [rubidia and cæsia] alone, a crimson of lithia, a yellow of soda, or a mixture of soda with potassa or lithia.* In the latter case, test the residue for potassa [rubidia and cæsia], by tartaric acid, or platinic chloride and alcohol in not too dilute solution; for lithia, by boiling with sodic carbonate and phosphate, whereby a salt forms, soluble with difficulty; or by a mixture of anhydrous ether and alcohol, in which lithic chloride dissolves, recognizable by the crimson flame.</p> <p>b. <i>When magnesia is present.</i> Evaporate to dryness, ignite the residue gently, to remove ammonic salts, and warm with water. Add to the solution baryta-water, or milk of lime to alkaline reaction, boil, and filter. Remove the excess of baryta or lime by ammonia and ammonic carbonate (or of baryta by dilute sulphuric acid), and evaporate the filtrate to dryness. If there is a residue, proceed with it as in a. Or test for alkalies by the spectroscope.</p>
<p>* Potassa [rubidia, cæsia], soda, and lithia can also be distinguished by the effect of transmission through colored media upon their colored flames. If the substance to be tested (best as a sulphate) is held in the loop of a platinum wire in the outer envelope of a (pure blue) gas or alcohol flame, if soda be present the whole upper part of the flame will be colored yellow. If a flat glass bottle with parallel sides containing a solution of indigo is now brought between the eye and the flame, the color of the flame will entirely disappear, in case only soda be present; a simple change, however, to violet or red indicates potassa, or lithia. If the flame is then observed through deeply colored cobalt glass, the violet color remains by presence of potassa [rubidia and cæsia]; the last two as well as the alkalies in general are detected with most certainty by means of the spectroscope. [Traces of sodium are most readily detected, and distinguished from potassium, when both are in form of chlorides (free from organic acids and other bases), by placing a drop of the concentrated aqueous solution on a slip of glass, adding a drop of PtCl₄, and gently evaporating, when potassic platinic chloride will crystallize in octahedra, and the sodic salt in orange needles, best distinguishable by a magnifier.]</p>		

TABLE XI.
DETECTION OF ACIDS. PRELIMINARY EXAMINATION.

XI. Behavior of the more important Acids, or of the Halogens, upon Heating their Compounds with Concentrated Sulphuric Acid.

A quantity of the dry compound, about as much as will lie upon the point of a small knife, is placed in a test-tube and 3-4 times its volume of concentrated sulphuric acid poured upon it, then heated, but not to the boiling point of sulphuric acid. With all volatile acids, or those which suffer decomposition by sulphuric acid at a high temperature, the evolution of vapor or gas may be observed, from the properties of which, in most cases, the nature of the acid or of the halogen may be inferred.*

Non-Volatile Acids.	Acids Volatile, or Decomposable with Evolution of Volatile Products.		
<i>No gas or vapor is evolved. The compound does not blacken by ignition.</i>	<i>A colored gas is evolved. The compound does not blacken by ignition.</i>	<i>The vapors or gases evolved are colorless.</i>	
		<i>The compound does not blacken by ignition.</i>	<i>The compound is decomposed by ignition.</i>
		Mostly without separation of carbon.	With separation of carbon.
<p>Silicic Acid, recognizable by means of phosphorus salt before the blowpipe.</p> <p>Boric Acid, after addition of sulphuric acid, it colors the alcohol flame green.</p> <p>Phosphoric Acid, precipitable in neutral solution by magnesian sulphate, ammoniac chloride, and ammonia; in acid solution by ferric chloride and sodic acetate.</p> <p>Arsenic Acid, like the preceding, but the compound gives with sodic carbonate upon charcoal arsenical odor.</p> <p>Sulphuric Acid, the compound gives hepar when heated with sodic carbonate upon charcoal.</p> <p>Selenic Acid, like the preceding. The baryta salt is decomposed by boiling with concentrated chlorhydric acid.</p> <p>Tungstic Acid, recognizable by the blowpipe; becomes blue with zinc and chlorhydric acid.</p> <p>Molybdic Acid, recognizable by the blowpipe; becomes first blue, then brown with zinc and chlorhydric acid.</p> <p>Titanic Acid, recognizable by the blowpipe; becomes violet with zinc and chlorhydric acid.</p> <p>Iodic Acid. The violet vapors of iodine form on addition of ferrous sulphate. The compound deflagrates upon charcoal.</p>	<p>Iodohydric Acid, the violet vapor colors starch blue.</p> <p>Bromhydric Acid, the brown vapor colors starch a fiery yellow.</p> <p>Bromic Acid. Like the preceding; the salt deflagrates upon charcoal.</p> <p>Chloric Acid, the greenish-yellow gas readily explodes; the compound deflagrates upon charcoal.</p> <p>Hypochlorous Acid, yellowish-green chlorine gas, like the preceding discoloring solution of indigo.</p> <p>Nitrous Acid, red fumes; even with dilute sulphuric or nitric acid.</p> <p>Nitric Acid, nearly colorless acid fumes, which are <i>red</i> if chlorine be present; deeper red if ferrous sulphate or organic substances be added.</p>	<p>Carbonic Acid, odorless, renders lime-water turbid.</p> <p>Cyanic Acid, excites tears, and renders lime-water turbid.</p> <p>Sulphurous Acid, recognizable by its odor; colors dissolved potassic chromate green.</p> <p>Sulphydric Acid, recognizable by its odor; colors lead-paper brown.</p> <p>Chlorhydric Acid, fumes copiously, and precipitates a solution of silver on a glass rod curdy; this precipitate dissolves in ammonia.</p> <p>Nitric Acid, nearly colorless fumes, which become <i>red</i> upon addition of ferrous sulphate or copper filings.</p> <p>Fluohydric Acid, copiously fuming corrosive gas. A glass surface coated with wax and traced is rendered dim in the traced places by the gas. Fluorides develop in a glass tube with sulphuric acid, in addition to HF, also silicic fluoride gas, which gives a precipitate of silica on a glass rod moistened with water. Silicofluorides behave similarly; they also evolve silicic fluoride in a platinum crucible with sulphuric acid.</p>	<p style="text-align: center;"><i>The compound is decomposed by ignition.</i></p> <p style="text-align: center;">Mostly without separation of carbon.</p> <p>Oxalic Acid, develops carbonic acid and carbonic oxide; the lime salt is insoluble in acetic acid.</p> <p>Formic Acid, evolves only combustible carbonic oxide gas.</p> <p>Cyanhydric Acid, like the preceding, but evolves with dilute chlorhydric acid cyanhydric acid.</p> <p>Ferrocyanhydric Acid, like the preceding; the soluble compound is precipitated blue by <i>ferric</i> salts.</p> <p>Ferricyanhydric Acid, like the preceding; the soluble compound is precipitated blue by <i>ferrous</i> salts.</p> <p>Chromic Acid, evolves oxygen, and the fluid becomes brown or green. Gives a green bead with phosphorus salt.</p> <p>Hyposulphurous Acid. Trithionic " } * Tetrathionic " } Pentathionic " }</p> <p style="font-size: small;">* These acids, of which only the hyposulphurous (triosulphuric) is of frequent occurrence, evolve with sulphuric acid, sulphurous acid, with separation of sulphur. Their salts of the alkalies give hepar when heated in a glass tube.</p> <p style="text-align: center;">With separation of carbon.</p> <p style="text-align: center;"><i>a. Acids not volatile per se.</i></p> <p>All compounds of these acids are decomposed by concentrated sulphuric acid, blackening thereby and developing CO₂, CO, and SO₂.</p> <p>Tartaric Acid, the acid potassic salt is soluble with difficulty; the lime salt is soluble in caustic potassa.</p> <p>Racemic Acid; the lime salt is insoluble in ammoniac chloride.</p> <p>Citric Acid; gives a precipitate with excess of lime-water only on boiling.</p> <p>Malic Acid, is not precipitated by lime-water, either cold or warm.</p> <p>Lactic Acid, dissolves readily in ether. The lime salt is easily, the zinc difficultly, soluble in water.</p> <p>Tannic Acid, gives a white, viscous precipitate, with gelatine a blue-black with ferric salts.</p> <p>Galic Acid, not precipitable by gelatine; ferric salts produce a black precipitate.</p> <p>Uric Acid, gives a red color with ammonia, after evaporation with nitric acid.</p> <p style="text-align: center;"><i>b. Acids volatile per se.</i></p> <p>The compound does not blacken, or but slightly, with sulphuric acid.</p> <p>Acetic Acid, gives, with sulphuric acid and alcohol, acetic ether.</p> <p>Benzoic Acid, { Their neutral salts are precipitated a light brown by ferric chloride. Succinic " }</p>
<p>* If by the above methods a hydracid is found, the dry compound contains the corresponding halogen combined with a metal. In a mixture of salts other reactions often take place; thus a metallic chloride along with a nitrate develops chlorine and red vapors; along with a chromate brownish-red fumes of chlorochromic acid, etc. The chlorides of <i>mercury</i> are hardly decomposed by sulphuric acid. <i>Metallic sulphides</i> with concentrated sulphuric acid frequently develop sulphurous acid.</p>			

TABLE XII.
DETECTION OF ACIDS.

XII. Behavior of the more important Acids towards Precipitants.

A. *Detection of Acids in soluble compounds.*—The aqueous solution is *neutral, acid, or alkaline*, to be determined by test paper. If the acid is to be sought in an ammoniacal solution, or one as neutral as possible, it is often necessary to remove the heavy metallic oxides or the earths present (according to Table VI.), by which means *metallic acids* are found, as well as *phosphoric or oxalic acid* combined with alkaline earths. The quality of the base often excludes the presence of one or more acids, thus rendering search for them unnecessary; generally an acid cannot be present in a *neutral or acid solution* which already contains the same metallic oxide that must serve as precipitant for this acid; *e. g.*, no *sulphuric acid*, detected by baryta, can be present in a soluble *baryta* compound; no *chlorine* in a *silver* compound, soluble in acids, etc. (For exceptions in alkaline solutions, see Table XII. below.) It is evident that in any compound such acids as *have been added* (for solution or neutralization) need not be sought; in all compounds where the reagent can act as precipitant through its *acid* (or halogen) the *nitrate* is used; *e. g.*, in compounds of silver, of lead, or of mercurous oxide, baric nitrate is used (instead of baric chloride). (See continuation, Table XIII.)

Are Precipitated by Chlorhydric or Nitric Acid :	Are Precipitated by Baric Chloride (or Baric Nitrate) :	Are Precipitated by Calcic Chloride :		Are Precipitated by Magnesic Sulphate (or Magnesic Chloride) :								
<i>From their soluble compounds, generally showing alkaline reactions.</i>	<i>From the solution previously acidulated with chlorhydric or nitric acid.</i>	<i>Only from neutral solution. The precipitate is soluble in acetic acid.</i>	<i>From neutral and from acetic solution. Precipitate is insoluble in acetic acid.</i>	<i>In the presence of ammoniac chloride and free ammonia.</i>								
<p>Silicic Acid, gelatinous; in dilute solution only after evaporating the acid fluid; also precipitable by ammoniac carbonate or chloride.</p> <p>Boracic Acid, crystalline, only from concentrated solutions. Colors the alcohol flame green upon addition of sulphuric acid.</p> <p>Antimonic Acid, white, soluble in tartaric acid.</p> <p>Tungstic Acid, white, by boiling, yellow; with zinc and chlorhydric acid, blue.</p> <p>Molybdic Acid, white, soluble in excess, with zinc and chlorhydric acid blue, finally brown.</p> <p>Sulphur, yellowish or white; with the evolution of SO₂ from hyposulphites, and H₂S from metallic polysulphides.</p> <p>Iodine, out of a solution of an iodide and an iodate or nitrite.</p> <p>Also several <i>oxides</i> and <i>sulphides</i> soluble in potassa, and <i>cyanides</i> or <i>chlorides</i> soluble in potassic cyanide. If the alkaline fluid be saturated with sulphydric acid, all the acids of the <i>metals</i> which form sulphides insoluble in acids, are precipitated, after acidulation, as <i>sulphides</i>.</p> <p>Of the <i>organic acids</i>, <i>benzoic, uric,</i> and <i>tartaric acid</i> (the latter as acid <i>potassa</i> salt) may be precipitated by acids from alkaline solution.</p>	<p>Sulphuric Acid, white, pulverulent; quite insoluble in water and in acids. (In the presence of too much and concentrated free acid baric chloride or baric nitrate is precipitated; soluble in much water.) The original compound gives bepar with sodic carbonate upon charcoal.</p> <p>Selenic Acid, like the preceding. The precipitate, when boiled with concentrated chlorhydric acid evolves chlorine, and sulphurous acid, then precipitates out of the solution red selenium. The original compound gives upon charcoal before the blowpipe the characteristic selenium odor.</p> <p>Silicofluohydric Acid, like the preceding, not out of very dilute solution. The original compound gives upon heating silicic fluoride and a metallic fluoride, with alkalies silica and a fluoride.</p>	<p>Phosphoric Acid, white, when freshly precipitated soluble in acetic acid without effervescence.</p> <p>Arsenic Acid, like phosphoric; also easily soluble in ammoniac chloride. The solution in chlorhydric acid is precipitable by sulphydric acid with the aid of heat.</p> <p>Boracic Acid, white, easily soluble in ammoniac chloride; not precipitated from dilute solution. Turmeric paper dipped in a solution in chlorhydric acid becomes brown on drying.</p> <p>Carbonic Acid, white, soluble in acids with effervescence.</p> <p>Sulphurous Acid, white, only from concentrated solutions; with zinc and chlorhydric acid, evolves sulphydric acid.</p> <p>Tartaric Acid, white, soluble in ammoniac chloride and caustic potassa; the potassa solution of the precipitate becomes turbid by boiling.</p> <p>Citric Acid, white, but only by boiling the fluid supersaturated with lime-water or ammonia.</p> <p>Ferrocyanhydric Acid, forms slowly, soluble with difficulty in acetic acid.</p>	<p>Oxalic Acid, white; insoluble in ammoniac chloride; the precipitate also forms with calcic sulphate solution; the original compound evolves with concentrated sulphuric acid CO and CO₂ without blackening.</p> <p>Racemic Acid, white, insoluble in ammoniac chloride. Also formed with solution of calcic sulphate.</p> <p>Fluohydric Acid, gelatinous; the precipitate evolves, with concentrated sulphuric acid, fluohydric acid, which etches glass.</p> <p>Sulphuric Acid, white; not from dilute solutions; completely upon addition of alcohol.</p> <p style="text-align: center;"><i>Separation of Oxalic, Tartaric, Citric, and Malic Acid.</i></p> <p style="text-align: center;">Calcic chloride and lime-water are added to the alkaline reaction.</p> <p><i>Fluid</i> contains as salt of lime :— <i>Citric Acid.</i> <i>Malic Acid.</i></p> <p style="text-align: center;">Heat to boiling.</p> <table border="0" style="width: 100%;"> <tr> <td style="width: 50%; text-align: center;"><i>Precipitate:</i></td> <td style="width: 50%; text-align: center;"><i>Filtrate:</i></td> </tr> <tr> <td style="text-align: center;"><i>Calcic Citrate.</i></td> <td style="text-align: center;"><i>Calcic Malate.</i></td> </tr> </table> <p>Soluble in cupric chloride. Precipitable, after evaporation, by alcohol (and then to be further tested).</p>	<i>Precipitate:</i>	<i>Filtrate:</i>	<i>Calcic Citrate.</i>	<i>Calcic Malate.</i>	<p>Phosphoric Acid, white, crystalline; slowly if the solution be very dilute, soluble in all acids.</p> <p>Arsenic Acid, like the preceding. The <i>acid</i> solution of the precipitate is precipitated by sulphydric acid by the aid of heat.</p> <p>Tartaric Acid, white. The precipitate forms slowly and only in concentrated solution; it blackens on ignition.</p> <p style="text-align: center;"><i>Precipitate</i> contains as salt of lime :— <i>Oxalic Acid.</i> <i>Tartaric Acid.</i></p> <p style="text-align: center;">Treated with cold potassa lye.</p> <table border="0" style="width: 100%;"> <tr> <td style="width: 50%; text-align: center;"><i>Residue.</i></td> <td style="width: 50%; text-align: center;"><i>Filtrate.</i></td> </tr> <tr> <td style="text-align: center;"><i>Calcic Oxalate.</i></td> <td style="text-align: center;"><i>Calcic Tartrate.</i></td> </tr> </table> <p>Insoluble in acetic acid and in cupric chloride; soluble in chlorhydric acid. By boiling the potassa solution is precipitated gelatinous.</p>	<i>Residue.</i>	<i>Filtrate.</i>	<i>Calcic Oxalate.</i>	<i>Calcic Tartrate.</i>
<i>Precipitate:</i>	<i>Filtrate:</i>											
<i>Calcic Citrate.</i>	<i>Calcic Malate.</i>											
<i>Residue.</i>	<i>Filtrate.</i>											
<i>Calcic Oxalate.</i>	<i>Calcic Tartrate.</i>											

